Functions of A Complex Variable I
Instructor: Professor Gregery Buzzard
Course Number: MA 53000
Credits: Three
Time: 1:30–2:20 PM MWF

Catalog Description

Complex numbers and complex-valued functions of one complex variable; differentiation and contour integration; Cauchy's theorem; Taylor and Laurent series; residues; conformal mapping; special topics. More mathematically rigorous than MA 52500.

Elements of Stochastic Processes
Instructor: Professor Christopher Janjigian
Course Number: MA 53200, STAT 53200
Credits: Three
Time: 11:30–12:20 PM MWF

Catalog Description

A basic course in stochastic models, including discrete and continuous time Markov chains and Brownian motion, as well as an introduction to topics such as Gaussian processes, queues, epidemic models, branching processes, renewal processes, replacement, and reliability problems.

Probability Theory I
Instructor: Professor Chandra, Ajay
Course Number: MA 53800, STAT 538
Credits: Three
Time: 12:00–1:15 PM TTh

Catalog Description

Mathematically rigorous, measure-theoretic introduction to probability spaces, random variables, independence, weak and strong laws of large numbers, conditional expectations, and martingales.

Ordinary Differential Equations and Dynamical Systems

Instructor: Professor Nung Kwan Yip
Course Number: MA 54300
Credits: Three
Time: 12:00–1:15 PM TTh

Description

This is a beginning graduate level course on ordinary differential equations. It covers basic results for linear systems, local theory for nonlinear systems (existence and uniqueness, dependence on parameters, flows and linearization, stable manifold theorem) and their global theory (global existence, limit sets and periodic orbits, Poincare maps). Some further topics include bifurcations, averaging techniques and applications to Hamiltonian mechanics and population dynamics.

Prerequisites: one undergraduate course in each of the following topics: linear algebra (for example, MA 265, 351), differential equation (for example, MA 266, 366), analysis (for example, MA 341, 440, 504), or instructor's consent.

Main Textbook: *Differentiable Dynamical Systems* (Revised edition, 2017), J.D. Meiss (available online from Purdue Library page).

Real Analysis And Measure Theory

Instructor: Professor Monica Torres
Course Number: MA 54400
Credits: Three
Time: 10:30 AM–11:20 AM MWF

Catalog Description

Metric space topology; continuity, convergence; equicontinuity; compactness; bounded variation, Helly selection theorem; Riemann-Stieltjes integral; Lebesgue measure; abstract measure spaces; LP-spaces; Holder and Minkowski inequalities; Riesz-Fischer theorem.

Introduction To Functional Analysis

Instructor: Professor Plamen Stefanov
Course Number: MA 54600
Credits: Three
Time: 10:30–11:45 AM TTh

Description

This course will be based on the book: Reed and Simon, Methods of Modern Mathematical Physics, vol. I: Functional Analysis. I will cover most of the material in chapters II – VII there. We will start with Hilbert spaces, then consider the more general Banach spaces, Hanh–Banach, open mapping and the closed graph theorems. We will review some notions of general topology, and introduce locally convex spaces. In particular, I will present briefly the theory of tempered distributions. At the end of the course, we will study bounded linear operators on Banach and Hilbert spaces, including compact operators. The last topic to be covered is the Spectral Theory for bounded operators.

The Reed–Simon book is considered a classic for people viewing Functional Analysis as a tool for Mathematical Physics (hence the title of the four–volume book), PDEs, and analysis in general.

Introduction To Abstract Algebra

Instructor: Professor Shubhodip Mondal
Course Number: MA 55300
Credits: Three
Time: 11:30–12:20 PM MWF

Catalog Description

Group theory: Sylow theorems, Jordan-Holder theorem, solvable groups. Ring theory: unique factorization in polynomial rings and principal ideal domains. Field theory: ruler and compass constructions, roots of unity, finite fields, Galois theory, solvability of equations by radicals.

Linear Algebra I
Instructor: Professor Saugata Basu
Course Number: MA 55400
Credits: Three
Time: 12:30–1:20 PM   MWF

Catalog Description

Review of basics: vector spaces, dimension, linear maps, matrices determinants, linear equations. Bilinear forms; inner product spaces; spectral theory; eigenvalues. Modules over a principal ideal domain; finitely generated abelian groups; Jordan and rational canonical forms for a linear transformation.

Abstract Algebra II
Instructor: Professor Daniel Le
Course Number: MA 55800
Credits: Three
Time: 12:30–1:20 PM   MWF

Catalog Description

This course is an introduction to representation theory loosely following Representation Theory: A First Course by Fulton and Harris and Lie Groups, Lie Algebras, and Representations by Hall. The course will start with representations of finite groups before moving on to Lie groups with an emphasis on examples. Topics may include character theory, Schur orthogonality, induction, the Peter–Weyl theorem, highest weights, the Weyl character formula, Schur–Weyl duality, and the Borel–Weil theorem. The prerequisites are group theory and linear algebra (including multilinear algebra and tensor products). Familiarity with manifolds will be very useful but not essential.

Introduction In Algebraic Topology
Instructor: Professor Manuel Rivera
Course Number: MA 57200
Credits: Three
Time: 1:30–2:45 PM TTh

Catalog Description

Singular homology theory; Eilenberg-Steenrod axioms; simplicial and cell complexes; elementary homotopy theory; Lefschetz fixed point theorem.

Graph Theory
Instructor: Professor Giulio Caviglia
Course Number: MA 57500
Credits: Three
Time: 12:00–1:15 PM TTh

Catalog Description

Introduction to graph theory with applications.

Introduction to Additive Combinatorics
Instructor: Professor Ilia Shkredov
Course Number: MA 59500ADC

Credits: Three
Time: 2:30–3:20 PM MWF

Description

Additive combinatorics is a rapidly developing field of modern mathematics, located at the intersection of number theory and combinatorics. It utilizes a diverse set of tools, including dynamical systems, computer science, probability theory, geometry, and algebra. Roughly speaking, additive combinatorics is the study of combinatorial problems expressed through the group operation.

A foundational result that illustrates the field's concerns is Cauchy's theorem (1813) on addition in Z/pZ. The theorem says that for two sets A, B in Z/pZ, the size of the sumset $A+B := \{a+b : a \in A, b \in B\}$ is either equal to p or is at least $|A|+|B|-1$. This provides a general combinatorial statement about arbitrary sets, where the combinatorics is intrinsically linked to the group operation of addition. Other landmark results in additive combinatorics include van der Waerden's theorem on arithmetic progressions (which Khinchin called "a pearl of number theory"), Freiman's structural theorem on sumsets, the remarkable Green–Tao theorem on arithmetic progressions within the prime numbers, the Bourgain–Glibichuk–Konyagin theorem on the uniform distribution of multiplicative subgroups, and many others.

This course will introduce the fundamental results of the area and explore the relationships between additive combinatorics and other branches of mathematics, such as number theory, combinatorics, ergodic theory, graph theory, Fourier analysis, and geometry.

Extended Program:

1. Introduction and Coloring Problems.
2. Combinatorial Ergodic Theory and the Regularity Lemma.
3. Sumsets and Difference Sets.
4. Applications of Fourier Analysis in Additive Combinatorics.
5. Sets with no Arithmetic Progressions of Length Three.
6. Bohr Sets and the Spectrum.

7. Almost Periodicity.
8. Freiman's Theorem on Sets with Small Doubling.
9. The Sum-Prod uct Phenomenon: The Real Case.
10. The Sum-Product Phenomenon: The Finite Field Case.
11. Gowers Norms.
12. Multiplicative Combinatorics.

Book: Terence Tao and Van H. Vu, Additive combinatorics

Prerequisites: 16*** (first year calculus).
All levels, undergraduate/graduate.

Complex algebraic geometry and abelian varieties
Instructor: Professor Donu Arapura
Course Number: MA 59500CAG
Credits: Three
Time: 12:00–1:15 PM MWF

Description

This is a course on complex algebraic geometry with special emphasis on class of algebraic varieties called abelian varieites. These are higher dimensional analogues of elliptic curves. A fundamental theorem in complex algebraic geometry is Kodaira's embedding theorem, which tells us when a compact complex manifold is a smooth projective variety. When applied to a torus $\mathbb{C}^g/L$, Kodaira's theorem reduces to an old theorem of Riemann characterizing abelian varieties. I probably won't prove Kodaira's theorem in full generality, but I will prove Riemann's theorem since it is not that difficult. Although Abelian vari eties are somewhat special, we will see that any nonsingular projective variety can be "linearized" to obtain an abelian variety called the Albanese variety. This is a very important tool in algebraic geometry. This is more or less the content of part I.

Part II will discuss some more advanced topics such as moduli theory of abelian varieties. Depending on how well people follow the first part, I might go on to discuss proof of Deligne's theorem, and its refinement by Andr´e, that Hodge cycles on Abelian varieties are absolute/motivated.

Although, I won't follow any textbook closely, I will suggest the following references [1, 3, 4] below. I'll also type up notes as I go. As far as prerequisites are concerned, a good knowledge of basic algebra and complex analysis and topology is essential. And something more at the level of basic algebraic geometry, differential geometry, or algebraic topology would be recommended as well.

1. Birkenhake, Lange, Complex Abelian varieties
2. Deligne, Milne, Ogus, Shi, Hodge cycles, motives and Shimura varieties
3. Griffiths, Harris, Principles of Algebraic Geometry
4. Mumford, Abelian varieites

An Introduction to Kasparov's KK-Theory

Instructor: Professor Marius Dadarlat
Course Number: MA 59500KK
Credits: Three
Time: 4:30–5:45 PM TTh

Description

This course offers an introduction to Gennadi Kasparov's bivariant K-theory, a powerful framework in noncommutative geometry and operator algebras. KK-theory sheds new light on topological K-theory and K-homology by unifying them and extending their reach to the setting of C^*-algebras. It provides important tools for the study of elliptic operators and index theorems. While the course emphasizes applications to operator algebras, it also explores important connections to the Atiyah–Singer index theorem.

1 List of Topics on KK-Theory

1. C^*-algebras and Hilbert C^*-modules
2. Adjointable and compact operators on Hilbert modules
3. Review of K-theory for C^*-algebras and Bott periodicity
4. Kasparov modules: definitions, examples, and degeneracy
5. Construction of KK-groups and basic properties
6. Functoriality in KK-theory
7. The Kasparov product and its properties
8. Six-term exact sequences in KK-theory
9. Categorical perspectives and universal coefficient theorems
10. Applications to classification theory of amenable C^*-algebras
11. Brown-Douglas-Fillmore theory
12. Elements of equivariant KK-theory
13. Applications to index theory
14. The Baum-Connes conjecture and selected applications

2 Prerequisites

(1) Functional analysis (e.g., Hilbert spaces, bounded operators).

(2) Basics of C^*-algebras (e.g., representations, ideals, approximate units, spectral theorem for normal operator, functional calculus).

Familiarity with topological K-theory (e.g., vector bundles, Bott periodicity) or (pseudo)differential operators is helpful but not required.

Grading: Based on attendance and in–class participation

3 References

- Bruce Blackadar, *K-Theory for Operator Algebras* (2nd ed., 1998) – Chapters on KK-theory and applications.
- Kjeld Knudsen Jensen and Klaus Thomsen, *Elements of KK-Theory* (1991)
- Nigel Higson and John Roe, *Analytic K-Homology* (Oxford Mathematical Monographs, 2000)
- Heath Emerson, *An Introduction to C^*-Algebras and Noncommutative Geometry* (Birkhäuser Advanced Texts Basler Lehrbücher, 2024)
- Additional readings will be provided via Brightspace
- I may also post supplementary notes.

Lie Algebras
Instructor: Professor Oleksandr Tsymbaliuk
Course Number: MA 59500L
Credits: Three
Time: 2:30–3:20 PM MWF

Description

This is an introductory course on Lie algebras. Our main focus will be the study of finite-dimensional Lie algebras, with the key emphasis placed on the semisimple ones that admit a beautiful complete theory. The course is expected to fit a wide range of students: both graduate and strong undergraduate mathematics students, as well as graduate physics students.

A Lie algebra is a vector space equipped with a bilinear operation, called a *Lie bracket*. Despite this abstract definition, one should not forget their historical origin in the context of the Lie group theory – a mathematical treatment of continuous symmetries. Notably, Lie groups are determined by their linear approximation at the identity, called *the Lie algebra of a Lie group*. This allows to reformulate the theory in purely algebraic terms of Lie algebras (viewing them as spaces of "infinitesimal" symmetries) and motivates many related problems.

While being of independent interest, this subject finds interesting applications in other areas of mathematics and mathematical physics: algebraic combinatorics, differential geometry, topology, number theory, partial differential equations, quantum physics, and many more.

Tentative list of topics: Lie groups and the exponential map, nilpotent and solvable Lie algebras, theorems of Engel and Lie, Cartan subalgebras, Killing form and Cartan's criteria, structure of semisimple Lie algebras, root systems, Weyl group, Dynkin diagrams, classification and construction of semisimple Lie algebras, representations of semisimple Lie algebras, Weyl character formula, Casimir operator, theorems of Levi and Maltsev.

Prerequisites: Basic notions from algebra, especially linear algebra (general familiarity with topology and manifold theory will be useful for the first 3 weeks).

Mathematical Biology
Instructor: Professor Alexandria Volkening
Course Number: MA 59500MB
Credits: Three
Time: 9:00–10:15 AM TTh

Description

This course will introduce participants to mathematical biology with a mathematical modeling-centric perspective. We will discuss several research vignettes, such as examples from medicine, agriculture, and developmental biology, and use biological questions to illustrate both classic approaches and emerging techniques in applied mathematics. For example, we will discuss compartmental modeling, dynamics on and of networks, parameter estimation, reaction-diffusion equations, and agent-based modeling. We will also highlight how data-driven methods, such as equation learning and applied topological data analysis, are being applied in new ways to address challenges in mathematical biology now. Students will gain experience building mathematical models, identifying modeling choices, choosing model complexity appropriately, and combining models and data.

Complementing this, we will talk about methods for effectively communicating mathematics in written and oral form, as well as collaborating across disciplinary boundaries. Throughout the course, we will point out biology–math feedback loops, looking for how math can suggest experiments and how taking a biological perspective can drive new mathematical questions. In the latter portion of this course, student teams will each complete and present a mini research project.

Other notes: There will be no exams, and grades will be based on participation, a few homework assignments, and the mini research project. In terms of background, experience with linear algebra and differential equations at the undergraduate level will be assumed, and some experience with programming is encouraged. No textbook is required, and course material will include instructor notes.

Introduction to Number Theory
Instructor: Professors Alisa Sedunova
Course Number: MA 59500NT
Credits: Three
Time: 12:00–1:15 PM TTh

Prerequisites:

This course is intended for third- or fourth-year undergraduate students or beginning graduate students who have taken and obtained a grade of B− or better in MA 35301 (Linear Algebra II). Students should have basic competence in mathematical proof.

Description

Number Theory studies the properties of integers, and includes the theory of prime numbers, the arithmetic structures that underlie cryptosystems such as RSA, Diophantine equations (polynomial equations to be solved in integers, including the topic of Fermat's Last Theorem), and rational approximations that distinguish algebraic and transcendental numbers. Although a topic studied for more than two millennia, it is the subject of intense active current research, and connects with many other areas of Mathematics.

This course serves as an introductory exploration of Number Theory, without an abstract algebra prerequisite, so that final-year students without a pure mathematics background will find this accessible. Connections with abstract algebra will, however, be noted for interested students, and the material should provide reinforcement and preparation for abstract algebra for those with ambitions in this direction.

Content

The course will broadly follow the structure and spirit of *An Introduction to the Theory of Numbers* by Hardy and Wright, with selections adapted to the level and objectives of the class.

We begin with the fundamental properties of prime numbers, the Euclidean algorithm, unique factorization, and the theory of congruences, including the Chinese Remainder Theorem. We then proceed to the multiplicative structure of the integers modulo m, primitive roots, Legendre and Jacobi symbols, quadratic reciprocity, illustrative examples of quadratic congruences, and arithmetic and multiplicative functions.

Subsequently, the Prime Number Theorem will be stated without proof, with emphasis placed on its consequences and general significance, while establishing several weaker yet non-trivial estimates for the prime-counting function(s).

The latter part of the course is devoted to binary quadratic forms and their role in the representation of integers, together with selected topics in Diophantine approximation and transcendence, continued fractions, Pell's equation, aselected remarks related to Fermat's Last Theorem (subject to time constraints).

Companion Text(s)

The following is a list of sources used by the instructor in preparing this course. Students are welcome to consult any of these references in addition to the lecture notes, although it is neither necessary nor expected that they study all of them in detail.

(1) *Introduction to Analytic Number Theory*, by Tom M. Apostol, Springer, 1976.

(2) *An Introduction to the Theory of Numbers*, by G. H. Hardy and E. M. Wright, 6th edition, Oxford University Press, 2008.

(3) *The Distribution of Prime Numbers*, by Dimitris Koukoulopoulos, Graduate Studies in Mathematics, Vol. 203, American Mathematical Society, 2019.

(4) *An Introduction to the Theory of Numbers*, by Ivan Niven, Herbert S. Zuckerman, and Hugh L. Montgomery, 5th edition, Wiley, 1991.

(5) *Introduction to Analytic and Probabilistic Number Theory*, by Gérald Tenenbaum, 3rd edition, American Mathematical Society, 2015.

The main textbook would be *An Introduction to the Theory of Numbers*, by G. H. Hardy and E. M. Wright, 6th edition, Oxford University Press, 2008. If for some reason this does not work, one can use *An Introduction to the Theory of Numbers*, by Ivan Niven, Herbert S. Zuckerman, and Hugh L. Montgomery, 5th edition, Wiley, 1991 as the textbook as well (there is a large overlap anyways).

The course will be based on the instructor's notes distributed via brightspace, the HWs are to be submitted there as well.

Assessment

Course credit will be based on bi-weekly homeworks —— the top 5 scores are totalled; two in class mid-terms and final exam.

Introduction to Fourier Integral Operators

Instructor: Professor Antonio Sa Barreto

Course Number: MA 59500PDO

Credits: Three

Time: 4:30–5:45 PM TTh

Description

This will be a continuation of MA59500PDO taught during the fall 2025 by Prof. Stefanov. We will cover the calculus of Fourier integral operators (FIOs), which is a generalization of pseudodifferential operators. Pseudodifferential operators were developed as a tool to study elliptic equations, more specifically, they are used to construct parametrices of elliptic operators, but they are not quite suitable for constructing parametrices for hyperbolic equations, such as the wave equation, and this is one of the main roles of FIOs. Such operators also appear in quite different contexts, for example, Radon transforms and their generalizations are examples of FIOs.

We will carefully study the local theory of FIOs, which is already quite involved, and we will touch upon the global theory of FIOs. We will cover applications to scattering and spectral theory. We will mostly follow the textbook Microlocal Analysis for

Differential Operators, by A. Grigis and J. Sjöstrand (London Mathematical Society Lecture note Series, #196. Cambridge University Press), but we will use other sources for applications of the theory.

Finite Tensor Categories and Quantum Invariants

Instructor: Professor Xingshan(Shawn) Cui
Course Number: MA 59500QI
Credits: Three
Time: 1:30–2:45 PM TTh

Description

Fusion categories, quantum groups, and quantum invariants of knots and 3-manifolds form a remarkably deep triangle of ideas at the intersection of algebra, topology, and physics. Classically, the semisimple framework of fusion categories has played a central role in producing powerful invariants of knots and 3-manifolds, such as the Jones polynomial. However, to push beyond existing boundaries, it has become increasingly important to generalize these ideas to non-semisimple settings for compelling reasons.

First, the representation categories of quantum groups at roots of unity are not automatically semisimple. Second, it has been shown that 3-manifold invariants derived from non-semisimple tensor categories often capture more subtle and powerful information than their semisimple counterparts. Finally, in dimension four, quantum invariants constructed from semisimple categories fail to distinguish smooth structures on 4-manifolds.

This course introduces the construction of quantum invariants of knots and manifolds from categories that are not necessarily semisimple, with the semisimple case appearing naturally as a special instance. The first half of the course develops the algebraic foundations, beginning with (locally) finite Abelian categories and adding structures such as tensor products, duality, braiding, and twists, while covering key topics including projective covers, projective generators, modified quantum traces, and chromatic morphisms. The second half shifts to a more topological perspective, exploring skein modules on surfaces and 3-manifolds, and constructing quantum invariants of knots, 3-manifolds, and 4-manifolds from finite tensor categories. More generally, the course will show how such constructions give rise to topological quantum field theories that capture richer information than invariants alone, with classical theories such as Reshetikhin-–Turaev and Crane–Yetter appearing along the way; background on surgery and handle decompositions of manifolds will also be included.

The course is designed to be largely self-contained, though familiarity with basic category theory (functors, natural transformations), module theory (representations of groups and algebras), and basic topology (manifolds, knots) will be helpful.

The Topology, Geometry, and Algebra of Loop Spaces
Instructor: Professor Manuel Rivera
Course Number: MA 59500TGA
Credits: Three
Time: 12:00–1:15 PM TTh

Description

Course Description: Spaces of loops, paths, and strings in a background geometric space are ubiquitous across mathematics and physics. This course will explore both classical results and modern research directions concerning the structure of loop spaces, with an emphasis on their broad relevance to topology, geometry, algebra, and mathematical physics. While the exact trajectory will depend on the interests of participants, possible topics include:

1) The topology of loop spaces: continuous, piece-wise linear, smooth, H^1-loops, the compact-open topology, fibrations

2) The algebraic topology of loop spaces I: singular and simplicial (co)homology, Serre spectral sequence, homotopy groups, loop spaces and classifying spaces

3) The algebraic topology of loop spaces II: operads, iterated loop spaces, and recognition principle

4) Combinatorial models for loop spaces: simplicial and cubical constructions, polytopes inspired by loop spaces

5) Loop spaces and homological algebra: Hochschild an cyclic homology of algebras and coalgebras and their relevance to loop spaces in topology and geometry, iterated integrals

6) The geometry of loop spaces I: infinite dimensional manifolds, Riemannian metrics, length and energy functional, Morse theory

7) The geometry of loop spaces II: closed geodesics, the Gromoll–Mayer Theorem, Bott's iteration of the index formulas, Vigué–Poirrier–Sullivan Theorem

8) The geometry of loop spaces III: quantitative topology

9) Loop spaces and symplectic topology: relation between loop space homology and the symplectic homology of the cotangent bundle

10) String topology: what we know about the structure, meaning, and computation of operations on loop spaces constructed through intersection theory

The course is open to advanced undergraduates, graduates, faculty, and anyone with basic knowledge of algebraic topology and differential geometry.

Numerical Methods for PDEs
Instructor: Professor Di Qi
Course Number: MA 61500
Credits: Three
Time: 9:30–10:20 AM MWF

Description

This is an introductory course of numerical solutions to partial differential equations for any graduate students and senior undergraduates interested in computational mathematics, with emphasis on breadth rather than depth. The course will cover key concepts with a balance between analysis and implementation, including accuracy, stability and convergence of finite difference methods for time-dependent problems such as wave equations, parabolic equations and conservation laws. The finite element method for elliptic equations on structured meshes will also be introduced. Linear system solvers such as the conjugate gradient method and the multigrid method, and ODE solvers such as Runge–Kutta method will also be discussed. Sample Matlab codes will be provided to assist beginners, thus no prior knowledge of coding is required. Recommended prerequisites include linear partial differential equations, linear algebra, and Fourier analysis, all of which will be reviewed during the lectures. Feel free to send an email to `qidi@purdue.edu` for any questions.

Methods of Linear and Nonlinear Partial Differential Equations II
Instructor: Professor Matthew Novack
Course Number: MA 64300
Credits: Three
Time: 9:00–10:15 AM TTh

Description

This is a continuation of Math 642 and is the second semester in a one-year course on the theory of PDEs. Topics to be covered include Calderon–Zygmund theory, elliptic regularity theory, and an introduction to linear and nonlinear parabolic and hyperbolic PDEs. We will draw on the texts of Gilbarg and Trudinger, as well as notes by C. Mooney, T. Elgindi, and others. There will be no required textbook since I will produce my own course notes.

Instructor: Professor Nicholas McCleerey
Course Number: MA 66100
Credits: Three
Time: 3:00–4:15 PM TTh

Description

Algebraic Geometry II
Instructor: Professor Takumi Murayama
Course Number: MA 66500
Credits: Three
Time: 12:00–1:15 PM TTh

Description

This course is the second course in a two semester introductory sequence in algebraic geometry. Algebraic geometry is the geometric study of solutions to systems of polynomial equations. Algebraic geometry has interactions with many other fields of mathematics, including commutative algebra, algebraic topology, number theory, several complex variables, and complex geometry.

This second course will mainly focus on the theory of schemes, including the necessary background on sheaves and their cohomology. Planned topics (subject to change) include the following: Sheaves of Abelian groups. Locally ringed spaces and sheaves of modules. Schemes, properties of schemes. Separated, proper, and projective morphisms of schemes. Cartier and Weil divisors. Sheaves of differentials. Derived functors and sheaf cohomology. Čech cohomology, cohomology of projective space. Ext groups and sheaves. Serre duality. Higher direct images. Flat morphisms. Smooth morphisms. Formal schemes, the theorem on formal functions. The semicontinuity theorem. Applications to curves and surfaces.

Prerequisites: MA 55300, 55400, 55700, 56200, 57100, 57200, and 59500AG.

Text: Course notes will be provided. The notes will largely draw from *Algebraic geometry* by Robin Hartshorne (available at `https://doi.org/10.1007/978-1-4757-3849-0` via the Purdue library).

Optional texts: All texts listed below have free access options for Purdue students.

- *Éléments de géométrie algébrique* by Alexander Grothendieck and Jean Dieudonné (available at `http://www.numdam.org`).
- *Eléments de géométrie algébrique I* (second edition) by Alexander Grothendieck and Jean Dieudonné (available for short term loan at `https://n2t.net/ark:/13960/t42s6kw4b`).